March 17, 2003: Next-Generation Northstar Sets New Standard in Performance and Refinement For 2004 Cadillac XLR

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GM Powertrain has taken the Northstar 4.6-liter, dual-overhead-camshaft (DOHC) V-8 to a higher level of performance and refinement by developing a next-generation version of the highly regarded engine for the 2004 Cadillac XLR. The next-generation Northstar is the first adaptation to rear-wheel-drive (RWD) and all-wheel-drive (AWD) configurations.

"The next-generation Northstar was extensively re-engineered to provide drivers with a sophisticated, technologically advanced powerplant that will establish a new benchmark for luxury vehicles in performance, refinement and the total driving experience," said John Zinser, GM Powertrain Northstar chief engineer.

"This new Northstar does just that with smooth, refined performance throughout its entire operating range. It is quiet, yet tuned to give the driver

feedback from the environment. It operates even more cleanly and efficiently than its predecessors with excellent reliability and durability."

Improved performance

While refined operating characteristics were a priority in developing the new Northstar, the overall goal was exceptional performance.

The Northstar delivers a higher output across the entire operating range with targeted output of 320 horsepower (239 kW) at 6400 rpm and 310 lbs.-ft. (420 Nm) of torque at 4400 rpm. In addition to these peak values, new four-cam continuously variable timing has freed the engine from the traditional constraints of fixed-cams that can only provide either high horsepower or high torque.

The Northstar also has an increased 10.5:1 compression ratio; while premium fuel is recommended for maximum performance, it can be operated on regular unleaded fuel.

New technology and design features

The Northstar V-8 is a 90-degree, DOHC, four-valves-per-cylinder engine featuring an aluminum block and cylinder heads, and a valvetrain configuration with roller finger followers. While maintaining these basic features, the new RWD version provides a host of Northstar "firsts," new technologies and design features to position it as a segment leader:

- Four-cam continuously variable valve timing (VVT). The RWD Northstar is the first to use VVT for improved performance, refinement, economy and emissions.
- Electronically controlled, hydraulically actuated intake and exhaust cam phasers on all four camshafts take VVT to an impressive level of control. They allow intake and exhaust valves to operate independently of each other. This assures precise timing for opening and closing the valves and extremely accurate control of fuel injection and more efficient combustion with minimal compromise between emissions

and performance, all through the operating range from idle to high speed. The new VVT system also eliminates the exhaust gas recirculation (EGR) system and associated emissions hardware, reducing complexity and weight.

- Electronic throttle control (ETC). This is the first adaptation of ETC for Northstar, providing additional driving refinement. This allows the engine control system to precisely and seamlessly tailor vehicle performance to driver demands, relative to the conditions in which the vehicle is operating - with the driver only aware of the engine's smooth, instantaneous response. It also enables other functions, such as cruise control, torque management and traction control to be fully integrated, eliminating hardware complexity and improving reliability.
- Low restriction intake and exhaust manifolds and cylinder head ports. Cylinder head ports and exhaust manifolds were redesigned to ensure optimum airflow and cylinder-to-cylinder distribution for maximum performance and emissions control.
- Close coupled catalytic converters, mounted directly adjacent to the exhaust manifolds. They reach effective operating temperature more rapidly after engine start-up and minimize the time for emissions "light off." They also eliminate the need for supplemental converters or air injection reaction (AIR) systems to meet emissions requirements.
- A new air induction system, redesigned for enhanced capacity and noise attenuation. It features tuned resonators, additional resonators in the clean air duct and use of isolator pads in the clean air duct mounting.
- A more powerful engine control module (ECM) and high-speed local area network (LAN) communication system dedicated to engine and transmission control. An extremely powerful, state-of-the-art ECM, with a 16-bit, 24 MHz dual microprocessor, high memory capacity, and a redundant "safety" processor backing up the ETC enables the LH2 engine to provide its advanced capabilities.
- A new engine mounting system and more rigid block structure for outstanding operating smoothness and quietness. The XLR engine is not directly mounted to the transmission, but to a torque tube bell

housing. The XLR transmission is mounted in the rear. This provides the vehicle with nearly 50/50 weight distribution.

- Polymer-coated pistons, a steel crankshaft, and cast-iron manifolds to further reduce noise, vibration and harshness:
    - Polymer piston skirt coating allows a tighter fit, minimizing piston-to-bore noise potential. A larger piston pin helps dampen internal noise.
    - The steel crankshaft increases stiffness over more conventional cast-iron crankshafts.
    - Cast iron manifolds absorb noise more readily than fabricated manifolds.
- The first longitudinal application of the 4.6-liter Northstar V-8. To optimize coolant and oil flow for the new application, the water pump was moved to the front of the engine, which required changing all of the coolant passages and engine cavities - in effect, a virtual redesign of the block and heads.
- A specifically designed acoustic cover over the engine for more complete radiated noise containment. The cover, in addition to providing measurable noise reduction, maintains the attractive, neat and orderly under-hood harmony of the previous Northstar's installations. Any components not shielded by the cover have been carefully reviewed for finish and corrosion resistance.
- Cartridge block heater with "dry" installation to eliminate potential coolant leaks. The heater, which can be added for faster warm-ups in extremely cold weather, fits into a compartment outside the coolant passageway (rather than within the coolant circulation system) to eliminate any potential leaks.

New Hydra-Matic five-speed automatic transmission

The Hydra-Matic 5L50-E five-speed automatic transmission, developed to manage the high torque and horsepower of the Northstar 4.6 liter DOHC V-8 in the XLR, is one of the most technologically advanced transmissions on any highway or autobahn in the industry.

The 5L50-E transmission is a modification of the Hydra-Matic 5L40-E transmission used in Cadillac CTS.

"The 5L50-E was designed specifically to manage the high torque and horsepower of the next generation Northstar 4.6 liter DOHC, while combining the convenience of an automatic transmission with the feel of a high-performance manual transmission," said Rich Mardeusz, GM Powertrain Hydra-Matic 5L50-E assistant chief engineer. "And it does it in the same size package as the 5L40-E."

To meet the performance demands of the new Northstar, the 5L50-E was designed to manage at least a 25 percent increase in horsepower and torque over the existing 5L40-E. Among its host of performance features, the 5L50-E gives drivers the ability to partially override the normal automatic gear selection for greater control when more aggressive driving performance is desired.

Key features of the new 5L50-E include:

- Driver shift control (DSC) - Lets the driver switch from automatic to a clutchless five-speed high-performance manual transmission. Once the driver moves the gearshift lever into DSC mode, a quick tap is all that is required for smooth, crisp upshifts or downshifts within a selected range. Available on various European sport sedans, this is the first GM application of DSC.
- The transmission control module, or TCM, protects the powertrain when in DSC mode by monitoring vehicle speed, engine torque and the gear being used to determine if it should upshift automatically to assure the engine doesn’t over-rev and damage the transmission. It also has coast clutches in every gear, which provide engine braking in all five gears so the vehicle doesn’t free wheel if the driver takes his/her foot off the accelerator.
- Performance algorithm liftfoot (PAL) - PAL prevents upshifts while maintaining engine braking following continuous performance driving.

The TCM monitors driver behavior to determine whether or not to enable this feature. If the system detects a drop in vehicle speed prior to entering a turn, up to two downshifts can occur to provide the driver with maximum vehicle performance.

- Performance algorithm shifting (PAS) - The transmission controller modifies the automatic gear selection during closed throttle high lateral acceleration maneuvers, downshifting with nearly synchronous matching engine speed control for quick power up when the throttle is reopened. This feature is enabled instantaneously once the TCM recognizes a high lateral g input.

Advanced controls

The advanced performance capabilities of the powertrain in the Cadillac XLR is enabled by a sophisticated control system that performs functions beyond the scope of virtually any controller outside of NASA.

This control system gives the next-generation Northstar 4.6-liter DOHC V-8 unprecedented levels of power, performance and refinement, and provides the Hydra-Matic 5L50-E transmission with a host of capabilities, including the ability to switch from fully automatic to the characteristics of a clutchless high-performance five-speed manual.

The system is based on two new, extremely powerful controllers - the ECM and TCM are linked via an ultra-high-speed area network, the GM LAN protocol. The network also links them to all of the other critical vehicle performance functions, including ride, handling and brake control.

The ECM is a 16-bit, 24 MHz microprocessor, high memory control unit designed to integrate the engine's unique VVT system for both intake and exhaust valve trains, ETC, and closed coupled catalysts for meeting emission requirements without secondary emission control systems.

In a sense, the TCM also has been integrated with the ECM since the functions of the two controllers are so closely attuned. The ECM also serves as

the gateway between the GM LAN high-speed bus and the Class II functions via the body control module (BCM), which include chassis controls like anti-lock braking, traction control and adaptive suspension control.

Focus on quality

The meticulous attention paid to engineering detail in developing the new Northstar V-8 and Hydra-Matic 5L50-E is duplicated in its production at GM's engine plant in Livonia, Mich., and transmission plant in Strasbourg, France.

In a major commitment to Northstar engine quality, GM has installed state-of-the-art equipment and machinery and adopted a new manufacturing strategy and innovative processes to produce Northstar engines.

Highlights of GM's quality drive at Livonia include brand new engine assembly and cylinder head subassembly lines, upgraded machining operations, major increases in error proofing using new state-of-the-art technology and significant refinements and upgrades in the state-of-art cold test equipment used for final inspection.

The Hydra-Matic 5L50-E transmission facility in Strasbourg is also known for its painstaking approach to quality and the excellent warranty record of its products.

This commitment to quality is reflected in its assembly environment: transmissions produced at Strasbourg are hand assembled in a clean room. This approach alone has a positive impact on quality and warranty issues.

The chances of foreign matter being introduced into the transmission are minimized because assembly takes place in a clean room atmosphere. Only assemblers are allowed in the clean room and care is taken to be sure they don't track in dirt or dust. Components are delivered through sliding Plexiglas windows without the handlers ever entering the area.

A heritage of innovation

The RWD Northstar continues the tradition of innovation. With 16 patents when first introduced in 1992 and several in subsequent years, the FWD Northstar set new standards for luxury-car power, refinement and durability.

Continuous improvements in subsequent years were followed by a major upgrade in the 2000 model year. Highlights of the upgrade included adoption of a low friction valve train with roller finger followers for better economy and a low restriction intake manifold for quieter operation and emissions improvements. The FWD version of the Northstar will continue to be available for selected Cadillac applications in 2004.

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